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# HEAT EXCHANGER

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# HEAT EXCHANGER

[Wärmetauscher]



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## Description

State of the Art

The invention pertains to a heat exchanger having a plate-like design according to the preamble of Claim 1. A plate-like heat exchanger of this type for use in the food and confectionary industry is known, for example, from DE 31 17 496 A1. In order to reduce the flow resistance of the viscous product, the heat exchanger has several distributor tubes extending along its top side and they open out into plate channels. The transit of the liquid takes place using the gravity flow principle, wherein the product flows from above down through the plate channels. A plate heat exchanger of this kind, designed for a low flow resistance, is only marginally suitable for use in the confectionary industry, which deals primarily with cooking of sugar-containing solutions and mixtures with sugar substitutes. In this regard it is desirable to be able to change the length of the flow path of the product in the heat exchanger in a simple manner, so that it will have a length adapted to the particular product and flow volume, and thus

an appropriate dwell time. And secondly, the heat transfer from the heating medium, for example, steam, to the product should be variable with regard to the surface area for heat transfer and the temperature difference between the product and the heating medium, in order to achieve an optimum adaptation to the product, so that even sensitive products can be gently heated. In addition, for reasons for food safety, a good and simple cleaning and inspection of the product chamber should be possible, for instance, by using a configuration of the product space that is free of dead spaces which would also reduce the refitting time from one product to the other. For the reason of simple cleaning, for cooking the above mentioned products in the confectionary industry, the so-called coiled cooker is commonly used, although with regard to its size and its flexibility, it does have disadvantages in comparison to a plate-like heat exchanger.

## Advantages of the Invention

The heat exchanger with a plate-like design according to this invention and with the characterizing properties of Claim 1, has the decided advantage that it can be easily adapted to the particular product under consideration, with regard to the amount of heat to be transferred by the heat exchanger, with regard to its flow cross section and with regard to its flow length. In addition, its product chamber can be cleaned in a simple manner and affords the possibility for adaptation to various products.

Additional advantages and favorable embodiments of the heat exchanger according to this invention are indicated in the dependent claims and the description. A particularly favorable adaptation and a gentle heating of the product is possible when the heating cycles are separately controllable and regulated, so that the partial chambers will have different temperatures, for instance. An additional, simple means of adaptation of the device consists in a variation of the spacing of the product channels from each other. Due to a change in the height or of the flow cross section of the product channels, the rate of flow of the product can be adjusted in the heat exchanger. An additional optimizing to the particular product being processed is possible through an integration of static mixing elements into the product channels.

## Figures

Design embodiments of the invention are presented in the figures and are explained in greater detail in the text description below. Figure 1 shows a first heat exchanger in a longitudinal cross section using a schematic representation. Figure 2 shows the heat exchanger from Figure 1 in a cross section using a schematic representation, and Figures 3 and 4 present different design embodiments of the heat exchanger with modified head plates, also in longitudinal cross section using schematic representation.

Description of the Design Embodiments

The heat exchanger 10 illustrated in Figures 1 and 2 has a plate-like design and is used preferably for heating or cooking of mixed solutions containing sugar, and of mixtures with sugar substitutes in the confectionary industry. For simplicity, these mixtures will be called the "product" hereinafter. The housing 11 of the heat exchanger 10 has a box-like middle section 12 which is tightly sealed at its particular front sides by one head plate 13, 14 each, with gaskets (not illustrated) set in between. The two head plates 13, 14 also are connected to the middle section 12 by fast-snap connectors (not illustrated), so that a replacement of the head plates 13, 14 is possible in a relatively short time.

The interior 16 of the housing 11 is divided into three partial chambers 21, 22, 23 by means of two parallel spacer walls 19, 20 located parallel to the upper side 17 or underside 18 of the housing 11. An inlet 26, 27, 28 for a heating medium, for example, steam, opens into each of these partial chambers 21, 22, 23 at the one side wall 24 of the housing 11. The inlets 26, 27, 28 are each located at the highest point of the particular partial chamber 21, 22, 23, near the top side 17 or near the spacer walls 19,20. At the other side wall 29 of the housing 11 there is an outlet 31, 32, 33 for the heating medium for each partial chamber 21, 22, 23. These outlets 31, 32, 33, in turn, are each located at the lowest point of the corresponding partial chamber 21, 22, 23 near the spacer walls 19, 20, or at the underside 18. Due to the placement of the inlets 26, 27, 28, or outlets 31, 32, 33, respectively, a simple flow off of the condensed heating medium from the particular partial chamber 21, 22, 23 is possible.

Each of the partial chambers 21, 22, 23 is a constituent of a separate heating cycle (not illustrated in detail), so that the temperature of the heating medium can be separately controlled and regulated in each of the partial chambers 21, 22, 23.

Each of the partial chambers 21, 22, 23 is permeated by three product channels 35 having a rectangular cross section, and they are all positioned parallel to each other and are designed as straight and without back-cut. The length of the product channels 35 is such that they make a seal with the front sides of the middle section 12 of the housing 11, or with the front plates 13, 14. The width b of the product channels 35 is less than the width B of the housing 11, so that a space remains between the product channels 35 and the side walls 24, 29 of the housing 11. The height h of the product channels 35 in each of the partial chambers 21, 22,23 is inherently the same, but different from partial chamber to partial chamber. In the partial chamber 23 facing the underside 18 of the housing 11, the height h1 of the product channels 35 is smallest, whereas the height h3 of the product channels 35 is greatest in the partial chamber 21 facing the top side 17. In the middle partial chamber 22 the height h2 of the product channels 35 is between the heights h1 and h3. The result is that the cross sectional surface area of the product channels 35 is greatest in

partial chamber 21, but the cross sectional surface area of the product channels 35 in partial chamber 23 is smallest.

In order to allow a better mixing of the product flowing through the product channels 35, a state of the art static mixing element 37 can be introduced into each of the product channels 35. This mixing element 37 is adapted to the corresponding height h of the product channel 35 and consists of a sheet metal element, for example, with protruding corrugation, fins, etc., and due to the increased flow resistance, it ensures a better mixing of the product.

The product channels 35 can be integrally connected to each other by means of the heat plates 13, 14 at the front sides of the middle section 12, so that a continuous product flow is achieved. Thus according to Figure 1, overflow channels 38 are formed in each of the heat plates 13, 14 which each connect together two product channels 35 positioned one above the other in the middle section 11. Furthermore, at the one head plate 13, in the region of the underside 18 of the housing 11, there is a product inlet tube 39, and opposite the other head plate 14, in the vicinity of the top side 17 of the housing 11, there is a product outlet tube 41. The positioning or design of the overflow channels 38 is handled so that the product will move through the product channels 35 and be guided along a meander-like path, i.e., along the longest possible path between the inlet tube 39 and the outlet tube 41 in the middle section 12.

In the design embodiment of the heat exchanger 10a according to Figure 3, there are two overflow channels 38a created in the head plate 13a; these channels each connect together four product channels 35 positioned above each other. Conversely, in the other head plate 14a there is an overflow channel 38b for two product channels 35, one overflow channel 38c for three product channels 35 and one overflow channel 38d for four product channels 35. With this kind of design and configuration of the overflow channels 38a to 38d, there results a shorter flow path for the product in comparison to the first design embodiment.

In the design embodiment of the heat exchanger 10b according to Figure 4, the overflow channels 38e in the head plates 13b, 14b are designed so that all product channels 35 in the particular head plate 13b, 14b are connected to each other. Thus, an additional reduction in the flow path for the product is achieved, in comparison to the second design example.

In addition, it should also be pointed out that due to a changed design and configuration of the overflow channels 38, 38a to 38e, differently configured paths for the product can be created, which, in turn, will have different flow lengths for the product.

In order to allow simple drainage of the product channels 35 solely due to gravity, there is an outlet valve 42 provided in the inlet tube 39 outside the housing 11 of the heat exchangers 10, 10a, 10b; for simplicity, it is indicated only in Figures 1 and 2, but is also present in the other design embodiments. In this regard it is essential that the outlet valve 42 be located at the level of the lowest of the product channels 35, or even below it.

The same spacing 'a' is provided between the individual product channels 35. Numerous guide channels with a rectangular cross section (not shown in the figure) for the heating medium are located in the gaps 43 between the individual product channels 35. The length of the guide channels corresponds at least to the width b of the product channels 35. The placement of the guide channels is such that the heating medium is moved at a right angle to the product channels 35, that is, the heat exchanger will operate in a so-called cross flow method.

In addition, it should be mentioned that in the figure, for simplicity, only three product channels 35 are illustrated in each of the partial chambers 21, 22, 23. But actually, depending on the particular application, ten product channels 35 could be provided in each of the partial chambers 21, 22, 23, for example. The location of the spacer walls 19, 20 and thus the size of the partial chambers 21, 22, 23 should be designed preferably so that the same number of product channels 35 is present in each of the partial chambers 21, 22, 23. Since the height h of the product channels 35 is different in each partial chamber 21, 22, 23, but the spacing 'a' between the product channels 35 is always the same, the result is different size partial chambers 21, 22, 23.

The heat exchangers 10,10a, 10b described above operate as follows: By means of a pump (not illustrated) located in front of the inlet tube, the product is forced through the inlet tube 39 in the head plate 13, 13a, 13b. Due to the conveyance pressure of the pump, the product flows into the product channels 35 under heating and rising pressure in the heat exchangers 10, 10a 10b, wherein the flow path, i.e., its length, can be varied by means of the design described above by the use of differently configured head plates 13, 13a, 13b, 14, 14a, 14b. This means that the flow path in the heat exchanger 10 designed according to Figures 1 and 2, is longest, but in the heat exchanger 10b designed according to Figure 4, it is shortest. The result is that at the same temperature of the heating medium in the corresponding partial chambers 21, 22, 23, the temperature increase of the product will be greatest in the first design embodiment, but in the design embodiment according to Figure 4, it is smallest. Since each of the partial chambers 21, 22, 23 is a constituent of a separately controllable and regulated heating cycle, it is possible to provide the lowest temperature, for example, in the bottom partial chamber 23, and the greatest temperature in the upper partial chamber 21, so that the product will be heated very gently. This can be an advantage, especially with the use of heat-sensitive additives, such as milk, for instance. Of course, it is quite evidently also possible to combine two of the three heating cycles, for example, into one heating cycle with the same temperature of the heat carrier medium. As an additional advantage, it turns out that the height h3 of the product channels 35 in the partial chamber 21 allocated to the outlet tube 41 is greater than the height h1 of the product channels 35 in the partial chamber 23 associated with the inlet tube 38 [sic; 39]. Since the volume of the product increases with increasing temperature and with its transition into the two-phase region

(vapor and concentrate), this would otherwise lead to an increasing rate of flow of the product, given a constant height h of the product channels 35 along the flow path. In turn, this would have the consequence that the dwell time of the product in the partial space 21, and thus the possible temperature increase of the product, would be much less than in partial chamber 23, for example, in which the product has a smaller volume. This effect can be compensated by an appropriate design of the height h of the product channels 35 in the individual partial chambers 21, 22, 23. Thus, in spite of a relatively low temperature of the heating medium in the partial chamber 21, for example, a temperature increase of the product can still be attained, whereas otherwise given a smaller height h3 and the associated, shorter dwell time of the product, a greater temperature of the heating medium would be required.

The heat exchangers described above are particularly easy to clean, after disassembly of the head plates and removal of any mixing elements potentially present in the product channels, since the product channels are designed as a straight line and have no back-cut. Due to the formation of the product channels, the refitting time between two different products or the down time between operations or after a pause in production is relatively short.

Claims

1. Heat exchanger (10, 10a, 10b) having a plate-like design, for heating or cooking of a product, preferably of a sugar-containing solution or a mixture with sugar substitutes in the confectionary industry, with a housing (11) whose front sides are each tightly closed by a head plate (13, 13a, 13b, 14, 14a, 14b) and having at least one inlet (26, 27, 28) and one outlet (31, 32, 33) for a heat exchanger medium, and with several transit elements (35) for the product with these elements being located in parallel in the interior (16) of the housing (11) and having a rectangular cross section and also joined flush with the front sides of the housing (11), characterized in that the interior (16) of the housing (11) is designed so that it can be divided by means of at least one separating element (19, 20) into several partial chambers (21, 22, 23), that the length of the flow path for the product in the heat exchanger (10, 10a, 10b) is designed to be variable in accordance with the shape of the head plates (13, 13a, 13b, 14, 14a, 14b), that the head plates (13, 13a, 13b, 14, 14a, 14b) are designed to be exchangeable, and that the flow elements (35) that are allocated for the inlet (39) of the product into the heat exchanger (10, 10a, 10b) have a lesser height (h) and cross sectional surface area than the flow elements (35) that are allocated for an outlet (41) of the product from the heat exchanger (10, 10a, 10b).

2. Heat exchanger according to Claim 1, characterized in that each of the partial chambers (21, 22, 23) is coupled with a separately controllable and regulated heat cycle for the heat carrier medium.

3. Heat exchanger according to Claim 1 or 2, characterized in that the spacings (a) between the flow elements (35) placed one above the other in the housing (11) are always the same size.

4. Heat exchanger according to one of Claims 1 to 3, characterized in that the flow elements (35) for the product are designed as straight-line and without back-cut.

5. Heat exchanger according to one of Claims 1 to 4, characterized in that an outlet element (42) for the product is allocated to the flow element (35) that has the lowest level with respect to the flow path of the product in the heat exchanger (10, 10a, 10b).

6. Heat exchanger according to one of Claims 1 to 5, characterized in that the head plates (13, 13a, 13b, 14, 14a, 14b) have overflow channels (42a to 42e) [sic; (38, 38a to 38e)] for the product which connect together the flow elements (35) located one above the other.

7. Heat exchanger according to one of Claims 1 to 6, characterized in that the same number of flow elements (35) is allocated to each of the partial chambers (21, 22, 23).

8. Heat exchanger according to Claim 7, characterized in that the flow elements (35) each have the same height (h1, h2, h3) or the same cross sectional surface area in each of the partial chambers (21, 22, 23).

9. Heat exchanger according to one of Claims 1 to 8, characterized in that a mixing element (37) for the product is located in at least one of the flow elements (35).

Fig. 1

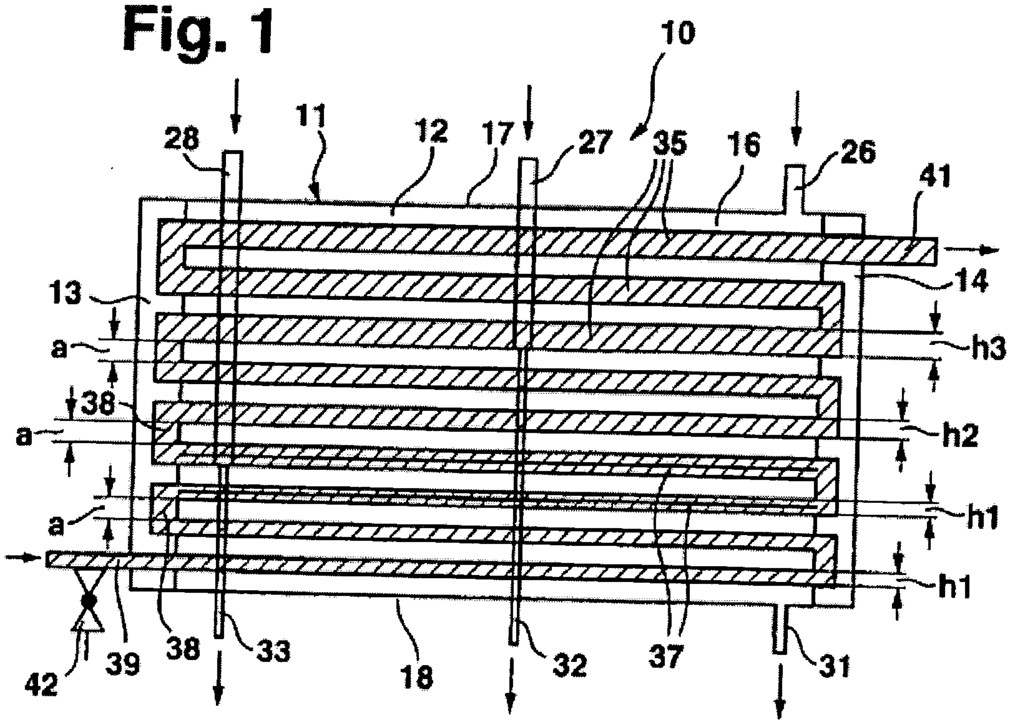

Fig. 2

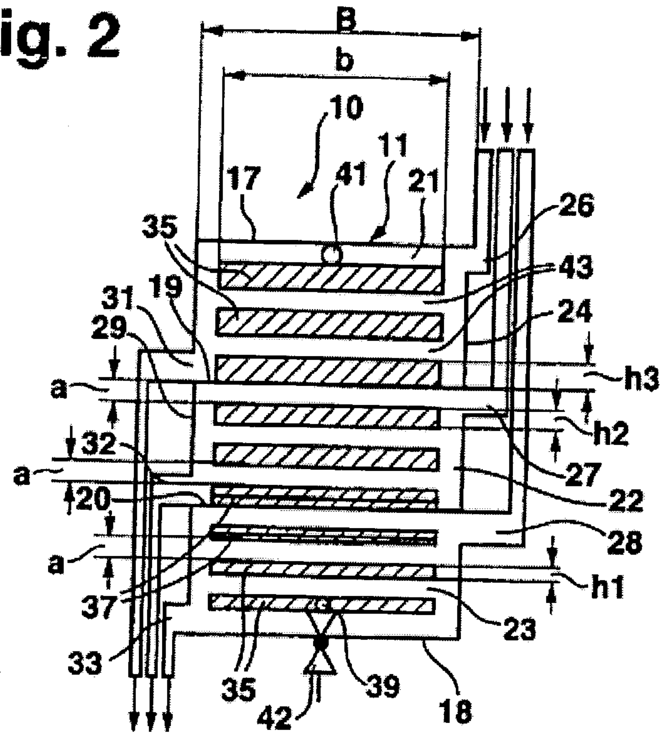
B
b
10
11
17
41
21
35
26
43
31
19
24
29
a
h3
h2
32
27
a
22
20
28
a
h1
37
23
33
35
39
42
18

Fig. 3

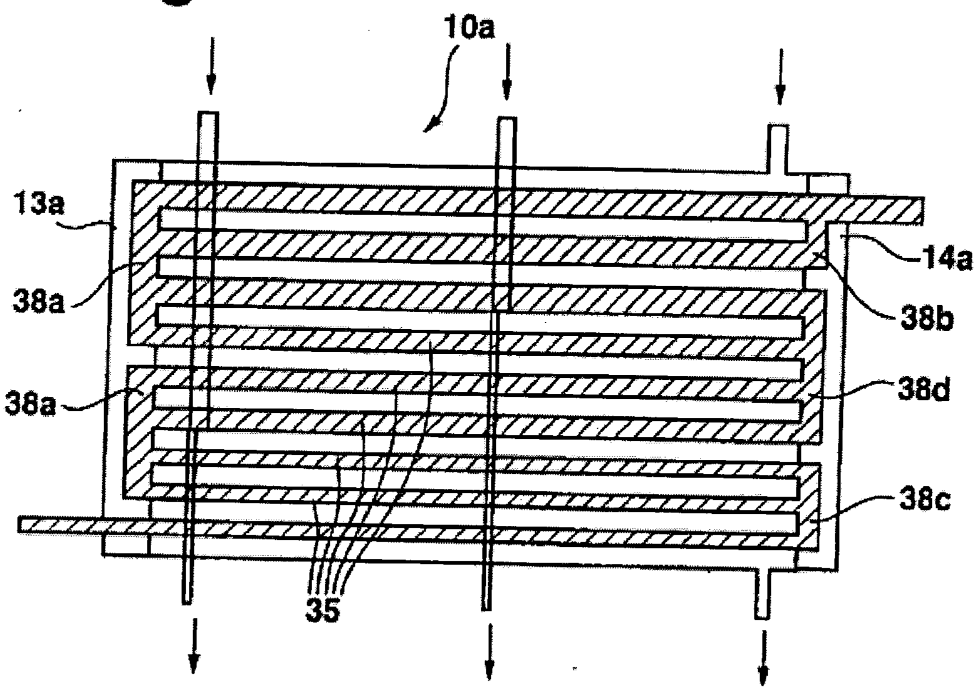
10a
13a
14a
38a
38b
38a
38d
38c
35

**Fig. 4**